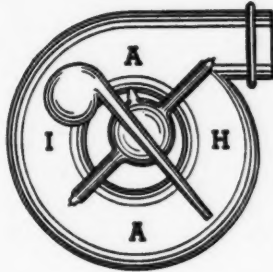


NOV 6 1948

AMERICAN
INDUSTRIAL HYGIENE
ASSOCIATION
QUARTERLY



VOLUME 9

JUNE, 1948

NUMBER 2

AMERICAN INDUSTRIAL HYGIENE ASSOCIATION

Officers

President

JAMES H. STERNER, M.D.

Eastman Kodak Company

President-Elect

E. C. BARNES

Westinghouse Electric Corporation

Past President

THEODORE F. HATCH

Industrial Hygiene Foundation

Secretary

W. G. HAZARD

Owens-Illinois Glass Company

Treasurer

CARLTON E. BROWN, Sc.D.

Camp Detrick, Frederick, Maryland

Executive Secretary

HENRY F. SMYTH, JR., Ph.D.

Mellon Institute, 4400 Fifth Avenue
Pittsburgh 13, Pennsylvania

Board of Directors

ANNA M. BAETJER, Sc.D.

The Johns Hopkins School of Hygiene
and Public Health

J. B. LITTLEFIELD

American Brake Shoe Company

MANFRED BOWDITCH

Lead Industries Association

FRANK A. PATTY

General Motors Corporation

ALLEN D. BRANDT, Sc.D.

Bethlehem Steel Company

L. M. PETRIE, M.D.

Georgia Department of Public Health

A. G. CRANCH, M.D.

Union Carbide & Carbon Corporation

H. F. SMYTH, JR., Ph.D.

Mellon Institute

N. V. HENDRICKS

Standard Oil Company (New Jersey)

HERBERT T. WALWORTH

Lumbermens Mutual Casualty Company

FRED R. INGRAM

California Department of Public Health

CHARLES R. WILLIAMS, Ph.D.

Liberty Mutual Insurance Company

Editorial Committee

LEONARD GREENBURG, M.D., Chairman

New York Division of Industrial Hygiene

PHILIP DRINKER

Harvard School of Public Health

L. J. GOLDWATER, M.D.

Columbia University School of Public Health

D. D. IRISH, M.D.

Dow Chemical Company

H. H. SCHRENK, Ph.D.

U. S. Bureau of Mines

Editor

WARREN A. COOK

Zurich Insurance Companies

AMERICAN
INDUSTRIAL HYGIENE
ASSOCIATION
QUARTERLY

Volume 9

JUNE, 1948

Number 2

This Issue

AN APPRAISAL OF PRESENT DAY FIELD INSTRUMENTS

ALFRED N. SETTERLIND 35

CHLORINATED HYDROCARBON-HYDROCARBON SOLVENT MIXTURES

MARGARET SUSOR and WILLIAM L. LEA 46

HEALTH CONTROL IN INDUSTRIAL LEAD WORKERS

Announcement of Lead Industries Association Publication

50

IS IT NECESSARY TO VENTILATE ALL DEGREASING INSTALLATIONS?

B. F. POSTMAN 51

The Annual Meeting of the AMERICAN INDUSTRIAL HYGIENE ASSOCIATION will be held April 5 through 7, 1949 at the Hotel Statler, Detroit, Michigan.

AMERICAN INDUSTRIAL HYGIENE ASSOCIATION QUARTERLY, an Official Publication of the AMERICAN INDUSTRIAL HYGIENE ASSOCIATION, published quarterly (March, June, September, December) by INDUSTRIAL MEDICINE PUBLISHING COMPANY, Chicago (publishers also of INDUSTRIAL MEDICINE, issued monthly, and INDUSTRIAL NURSING, issued monthly). STEPHEN G. HALOS, President; A. D. CLOUD, Publisher; WARREN A. COOK, Editor; CHARLES DRUECK, JR., Secretary and Treasurer; STEPHEN

G. HALOS, Advertising and Business Manager. PUBLICATION, EDITORIAL and EXECUTIVE Offices, 605 North Michigan Avenue, Chicago 11, Illinois. Subscription \$2.00 per year in the United States; \$2.50 per year in Canada; \$3.00 per year in other countries. Single copies 75 cents. Copyright, 1947, by Industrial Medicine Publishing Company, Chicago. Eastern Representative, H. GORDON HUNTER, 152 West Tenth Street, New York City 14, Telephone Watkins 9-1067.

Entered as second class matter May 3, 1948 at the post office at Sheboygan, Wis., under the Act of March 3, 1879.

**INDUSTRIAL HEALTH
HYGIENE AND SAFETY SERVICE**

6432 Cass Avenue, Detroit, Michigan
Trinity 1-4812

GORDON C. HARROLD, PH.D.
STUART F. MEEK, M.D.
AND ASSOCIATES

CONSULTING SERVICES

*Plant Surveys • Administrative and
Technical
Industrial Examination Ratings
Medicolegal Investigations
Insurance Problems*

C. O. SAPPINGTON, M.D., DR. P.H.
INDUSTRIAL HEALTH CONSULTANT
330 South Wells Street
Chicago 6, Illinois

**LEAD-IN-URINE
DETERMINATIONS**

A country-wide service for analysis of lead in urine for control of lead exposures. Lead-free sample bottles supplied in shipping containers.

Also other metals in trace quantities

HOY A. CRANSTON, Director

LABORATORY OF POLAROGRAPHIC ANALYSIS
7002 So. Halsted Street Chicago 21, Ill.
Phone: STewart 3-2022

Listings for

CONSULTANTS

and

SERVICES

in

INDUSTRIAL HYGIENE

AIHA QUARTERLY

Who's Who in Industrial Medicine

(Title by arrangement with The A. N. Marquis Company)

BIOGRAPHICAL sketches of the leading Industrial Hygienists of the United States and Canada, accurate, complete, authoritative; contained in "Who's Who in Industrial Medicine." Not in any sense a directory, but solely and definitely the assembly of the biographies of the important and outstanding men in the field. No sketch in the book can be paid for; no space in the book will be sold on any terms to any person or concern; the book will not carry any advertisements.

INVALUABLE AS A REFERENCE

Price \$10.00

Order Now

INDUSTRIAL MEDICINE PUBLISHING COMPANY

605 N. Michigan Ave., Chicago 11, Ill.

AMERICAN
INDUSTRIAL HYGIENE
ASSOCIATION
QUARTERLY

Volume 9

JUNE, 1948

Number 2

An Appraisal of Present Day Field Instruments

ALFRED N. SETTERLIND

Division of Industrial Hygiene
Illinois Department of Public Health

IN DISCUSSING the present day field instruments, I shall give you an appraisal from a somewhat different angle than the usual description of how well an instrument is capable of doing the work for which it is designed, the type of information which may be obtained in more detail from publications inspired by the designers or distributors of these items.

Instead, I shall dwell more upon the faults and limitations than upon the virtues of the instruments, and since the former are far more numerous than the latter, but no less important, I believe such a presentation will be of greater practical value.

I shall further limit my remarks to commercially available instruments which I have had an opportunity to study at first hand, and which I believe are in fairly common use at the present time.

The points I am presenting are based upon personal experiences during the last ten years and are the viewpoints of an engineer who is faced with the actual operation of these devices and responsible for obtaining reliable data of atmospheric pollution. Therefore, any resemblance between the description of these instruments as appearing in scientific and commercial literature and the one I intend to give is purely coincidental.

An appraisal must of necessity be based upon certain values; that is, how well does the object meet the qualifications set up as minimum standards in performing the ser-

vice for which it is intended. In the present appraisal, I have selected three of the most important qualifications a field instrument should have in order to be a useful tool of the engineer in the field. In order of importance, they are: (1) portability, (2) reliability, and (3) sensitivity.

You will notice that the question of accuracy is conspicuous by its absence. The reason for this is that permanent accuracy cannot, to my knowledge, be built into any mechanical device, especially a field instrument. The accuracy of even automatic recording devices, of which I know none that can be given the name of field instrument, must be periodically checked for accuracy. Furthermore, any instrument sold and intended for use by the industrial hygiene engineer should be capable of being used with reasonable accuracy; otherwise, it does not deserve to be called an instrument. The *degree* of accuracy obtainable with any device still depends upon the person who uses it.

Portability

LET US NOW examine what we mean by *portability* when we talk about field equipment. Does it mean that the object is capable of being moved by two strong men or rolled on casters like a grand piano? Or carried, with some difficulty, by one strong man from building to building in a factory? I believe this question of portability is the most important of all because I have noticed that when an instrument is easily handled, far more samples or determinations are obtained than when

Paper presented at the Tenth Annual Meeting of the American Conference of Governmental Industrial Hygienists, Boston, March 29, 1948.

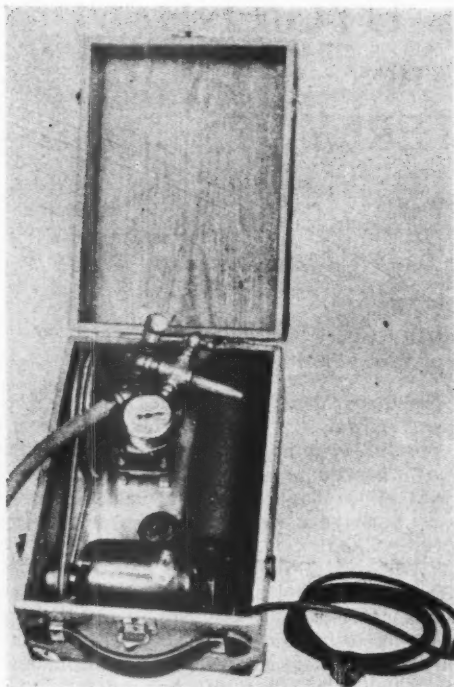


Fig. 1
Commercially available suction pump for standard impinger

the manipulations are hampered by heavy bulk or complicated arrangements. And to the busy industrial hygienist who, of necessity, must perform his duties with a certain amount of time limitations, weight is a real handicap.

This was very forcefully demonstrated to me a number of years ago. At that time, there was only one commercially available apparatus for the determination of chlorinated hydrocarbons, the Willson Chlorinated Hydrocarbon Sampling Apparatus. Since this device was extremely difficult to handle, we were lucky to obtain perhaps three or four samples per day and due to lack of portability of the instrument (it weighs 23 pounds), the samples were not very representative either. To remedy the situation, we designed a device weighing less than a pound, and by which a sample could be obtained on the average in 15 minutes. The result was both amazing and

gratifying. Looking back through the records, I find that where previously we took about 15 samples a year, we now average about 200. It seems to me that the number of samples obtained with an instrument is in inverse ratio to its weight.

Pursuing the question of portability, I suggest the following maximum weights for field instruments:

1. Instruments designed for stationary use in the field, i.e., for use with sampling hose—20 lbs.
2. Instruments to be carried strapped around the neck—10 lbs.
3. Instruments carried in the hand—two lbs.

Reliability

WITH REGARD to *reliability*, the instruments should be able to perform with minimum amount of manipulation, give reproducible results and require a minimum amount of servicing. Parts should be easily accessible for cleaning and inspection or replacement. These are requirements, the fulfillment of which necessitates careful engineering, a thing which is all too often lacking in field instruments.

Sensitivity

WITH REGARD to *sensitivity*, the instrument should be able to indicate concentrations with a sensitivity equal to 1% or 2% of the MAC value of the particular gas or vapor for which it is intended. Preferably, it should have a double scale with sensitivity ranges in the ratio of one to ten. The only instrument of this kind with



Fig. 2
Assembly for standard impinger including pump

which I am familiar is the M.S.A. Carbon Monoxide Indicator which has one scale range from 0—100 ppm and the other from 0—1000 ppm. Surely, with the great progress made in other fields of instrumentation it is not too much to expect that instruments used in our field should be capable of being made equally sensitive.

Limitations of Instruments

HOW WELL do our present day commercial instruments fulfill the above enumerated requirements for portability, reliability and sensitivity? To my recollection, there is only one which meets all of them; that is, the Bureau of Standards Colorimetric CO Indicating Device. Its enthusiastic acceptance by the field men with whom I have had a chance to discuss it emphasizes the value of portability and sensitivity. In regard to reliability, the final verdict must wait for future experience. Last year, we had on hand a supply of tubes supplied by the Bureau of Standards which we used in connection with an aspirating device of our own design. These were of excellent uniform quality, giving even stains of accurate color values. Since, however, we changed our supply of tubes to a commercial source, we have found occasional defective ones, some of which had granular material dropped down into the narrow portion of the tube, constricting the flow; others developed uneven stains, impossible to match.

Looking at the overall picture with regard to available instruments, most of them, even the best, exhibit serious limitations in one form or another compelling the conscientious investigator to revise, modify or even build his own equipment to satisfy his standards of performance. The number of suggestions appearing in the literature to improve the well known devices attests to the fact that such improvements are greatly needed.

Following are discussed some of the most common instruments which need modification or complete redesigning, and also certain improvements which we in Illinois have been forced to undertake to obtain reliable results.

Standard Impinger Equipment

FIG. 1 shows a commercial version of a suction pump, principally used in connection

with the standard (large size) impinger collection. Its principal fault is its weight, which is approximately 27 pounds. A companion piece to this is a heavy oak case for the storing of impinger bottles and accessories, weighing approximately another 27 pounds. In addition to these two, a tripod of rather heavy construction is supplied. The whole assembly is awkward and heavy, and to my knowledge, no change in the design or its weight has been attempted in the last ten years.

After purchasing this instrument in 1936, it did not take us very long to make arrangements for constructing and assembling an instrument which contained all the necessary flasks and accessories in one container of light weight. This is shown in Fig. 2. Its total weight is 20 pounds.

Flowmeter

WE USED this instrument for a long time, but did not feel that it fulfilled all the requirements of an accurate device. The rate of flow varies greatly in the field due to fluctuations in the line current. If unattended for any length of time, considerable errors in the volume of air sampled would occur. This variation many times may amount to as much as 15% to 20%.

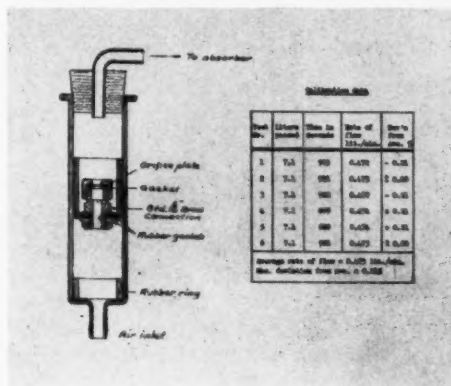


Fig. 3
Flowmeter and regulator

It has always seemed ridiculous to me that we pay great attention to developing accurate methods for analyses and have done very little to insure accuracy in the process of collecting the air samples. In order to

achieve the latter, it is almost necessary for a man constantly to watch the flowmeter and manipulate the device in order to hold the flow at the constant rate. This means that two men are needed where one should be sufficient.

In order to improve this situation, we started looking around for some means of producing a constant flow of air. Constant speed motors or constant voltage motors were tried but were not satisfactory, and it was necessary to find some means by which the motor and pump unit was controlled by the air flow itself. A scheme was finally hit upon in a round-about-way after the flowmeter, Fig. 3, was constructed. As shown in the drawing, the device is made from a 50 cc syringe, the tip of which a glass blower replaced with a piece of glass tubing of about 6 mm inside diameter. The syringe plunger was cut off and a hole drilled in the bottom. If the top of the syringe is connected to a hand-operated pump and the pump operated in such a way that the plunger would float slowly up and down, the average rate of flow will remain remarkably steady. Repeated calibrations

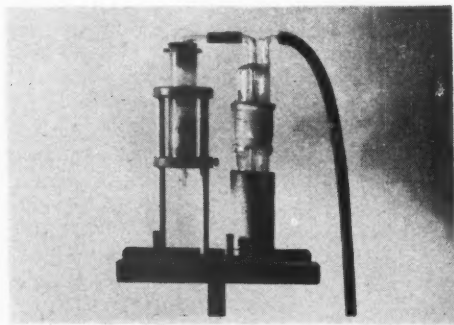


Fig. 4
Flowmeter-regulator unit connect to bubbler

with this flowmeter, at the rate of flow of $\frac{1}{2}$ liter per minute, showed the error will not exceed $\frac{1}{4}$ of 1%. At higher rates of up to one cubic foot per minute, errors will not exceed $\frac{1}{2}$ of 1%.

Fig. 4 shows this flowmeter used in connection with a bubbler. As a source of suction, a M.S.A. Midget Impinger Pump is being used; the latter, of course, having been modified by closing off the suction gage, and replacing the valve spring with

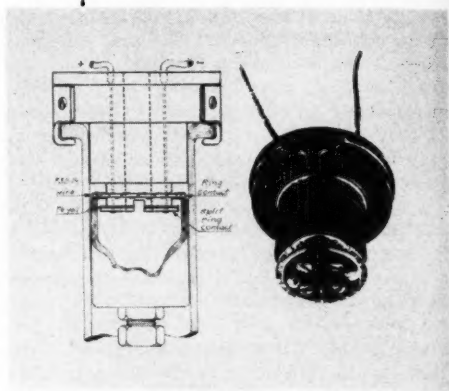


Fig. 5
Flowmeter-regulator unit for motor-driven pump

a piece of glass or brass tubing to close the air control valve, in order to operate against the high resistance offered by the fritted glass or aloxite bubbler.

Motor Control

THE EXCELLENT performance of this flowmeter device gave us the idea that perhaps the oscillating action of the plunger could be used to control a motor-operated suction pump. After considerable experimentation with various designs of switches, the one shown in Fig. 5 was finally adopted. It consists of a cylindrical plug of plastic having a central hole to serve as an air out-

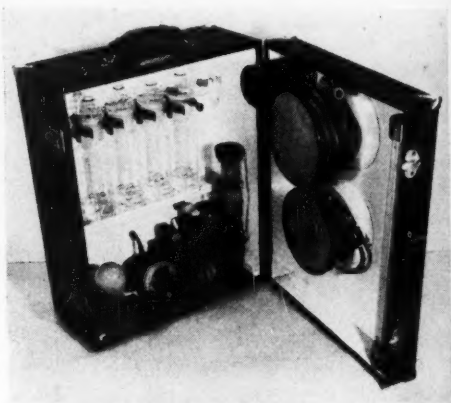


Fig. 6
Assembly for standard impinger with automatic regulator for motor

let and means for locking it to the syringe flange. Attached to the lower end of the plug is a split ring contact and resting on the two halves of this is a ring contact slightly larger in diameter and capable of being moved vertically, a slight distance. The two halves are shunted across a resistance, which, in turn, is connected in series with the motor. The contact surfaces are covered with platinum to resist the action of sparking. Normally, the top ring rests on the lower split ring and the current bypasses the resistance and flows

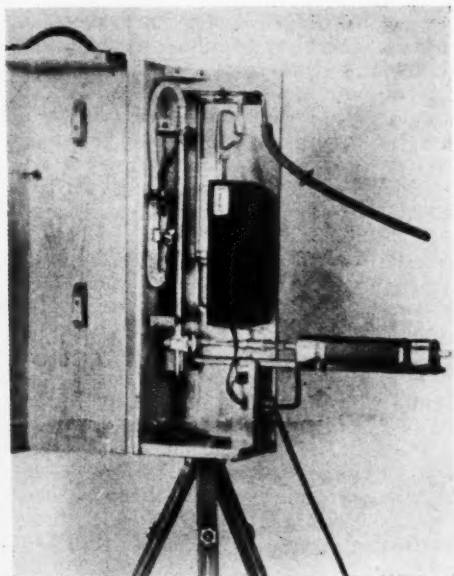


Fig. 7

Willson Chlorinated Hydrocarbon Sampling Apparatus

directly through the motor. When the predetermined rate of flow is exceeded, the plunger rises, lifts the top ring, and breaks the shunt, thus connecting the resistance in series with the motor. The resultant slowing down of the motor effects a reduction of flow and the plunger falls, leaving the top ring again in contact with the split ring. Thus, the air flow varies slightly around the medium value. The plunger is provided with a fitting to permit the exchange of orifice for any desired rate of flow. Tests showed that with this type of control, errors in flow rarely exceed 0.5%.

Fig. 6 shows the latest model of this automatic device¹ which has been found extremely reliable. The switch, which might have been expected to be troublesome, has been actuated on the first model of the instrument built in 1944 an estimated 5,000,000 times, and has not as yet been in need of repair.

Electrostatic Precipitator

THE DEVICE known as the *M.S.A. Electrostatic Precipitator* has been used universally for the collection of toxic fumes and dusts. Several features of this device are greatly in need of improvement. It lacks the proper portability. The flowmeter is relatively unreliable and the high voltage generator is frequently causing trouble. Moreover, voltage drops or interruptions of the high voltage are rather frequent, and since no warning signals are provided, there

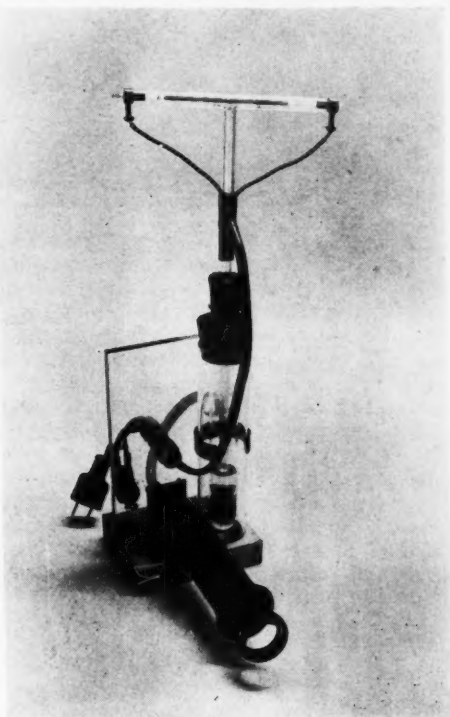


Fig. 8

Micro-furnace chlorinated hydrocarbon sampling apparatus

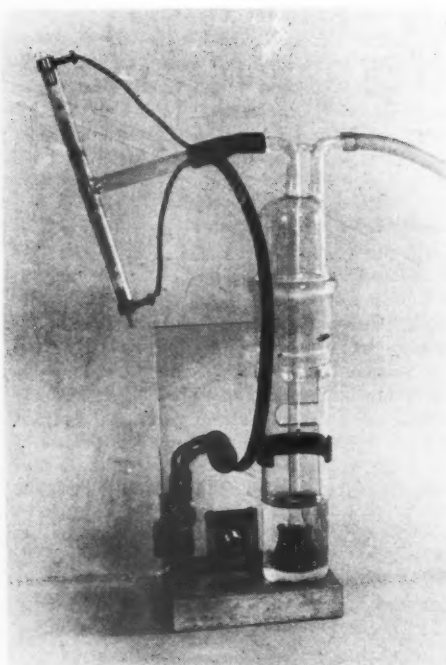


Fig. 9

Micro-furnace apparatus for chlorinated naphthalenes and diphenyls

is no way of telling when it is happening. In our Division, which uses three of these devices, there is usually an out-of-order sign attached to any one of these precipitators. It seems that a spare instrument is needed whenever frequent investigations have to be made. That the need for a more reliable instrument of this type has been felt is shown by the fact that at least two publications have appeared describing improved electrostatic precipitators; and from personal contacts with colleagues, I have heard of numerous modifications and improvements which have been made by individual hygienists.

Chlorinated Hydrocarbon Samplers

Fig. 7 shows the *Willson Chlorinated Hydrocarbon Sampling Apparatus*. It consists of laboratory glassware, assembled in a wooden case. It was chiefly designed for the collection and determination of chlorinated naphthalenes and diphenyls in air

and it is still the only commercially available instrument which can be used for that purpose. The manipulation is tricky and the construction is such that, in order to obtain any number of consecutive samples, the apparatus should be remodeled and reconstructed. While this can be done successfully, the description of the work entailed would be too long to describe here.

In Fig. 8 is shown a photograph of the instrument we are now using for determining chlorinated hydrocarbons, with the exception of the chlorinated naphthalenes and diphenyls. Its weight is approximately one pound, and it is extremely simple to operate. Samples are obtained by taking 30 pump strokes over about 10 minutes. The analysis is also very simple and accurate and may be performed in about 15 minutes per sample. Its most important part is a micro-furnace made from quartz T-tubing. Platinum wire is wound on a quartz rod and inserted in the cross branch of the T, and the platinum heated by connecting through a rheostat to the line voltage. The construction and operation of this instrument has been described elsewhere.² The furnace itself is very easy to construct by anybody in a short time and could, of course, be used with any other type of aspirating device. The aspirating device shown is a modification of that described by the Department of Scientific and Industrial Research, Great Britain, and may be used in connection with colorimetric and test paper methods described by that department.

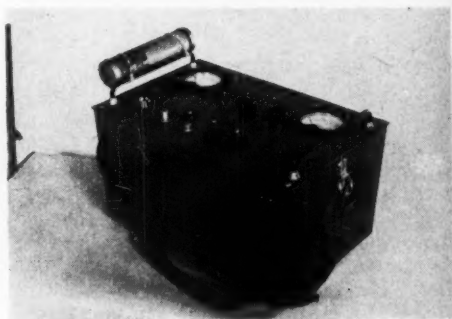


Fig. 10

General Electric Mercury Vapor Detector with cannister added for obtaining zero check in contaminated atmospheres

Fig. 9 shows the setup for obtaining samples of chlorinated naphthalenes and diphenyls, which require large sample volumes of air. In this case, the furnace is connected to a bubbler, and the air is aspirated through the bubbler by means of an automatically controlled suction device using a rate of two liters per minute. In order to keep the neoprene tube connection sufficiently cool, cotton or gauze is wrapped around the connection and kept moist with water from a dropper.

Mercury Vapor Detector

AN INSTRUMENT with which most industrial hygienists are familiar is the *General Electric Mercury Vapor Detector*, shown in Fig. 10. It is one of the smoothest working instruments I have encountered. However, it has several drawbacks:

1. For proper operation, this instrument must be worn around the neck, and since it weighs 29 pounds, its weight is a real handicap.

2. In similarity with other instruments of this type employing sensitive microammeters, the needle has a tendency to drift during the sampling operation, and there is no provision made to obtain zero setting while testing in contaminated atmosphere. The manufacturer recommends that zero setting be made by extending the hose through an open window; however, this operation has proven very impractical, especially in cold weather; and what are you going to do if there are no windows or the windows are either stuck or located 10 to 15 feet above the ground floor?

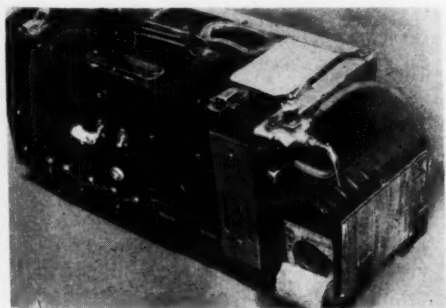


Fig. 11

M.S.A. Carbon Monoxide Indicator with cannister for zero check

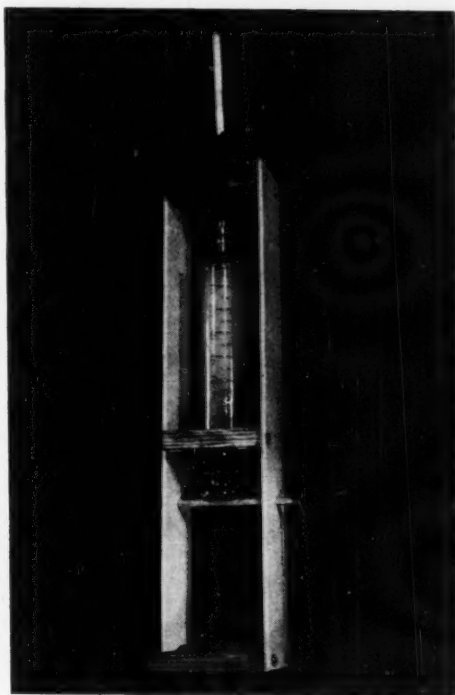


Fig. 12

Aspirating device for NBS Colorimetric CO Indicating Tubes

In order to overcome this handicap, a cannister was made out of a couple of mailing tubes and filled with activated charcoal with a layer of hopcalite in the center. The sampling hose is fitted with a rubber stopper and whenever necessary for obtaining zero, it is connected to the cannister and the balancing and sensitivity scales readjusted.

3. This vapor detector is also one of those instruments where greater sensitivity is needed.

Carbon Monoxide Indicators

THE M.S.A. *Carbon Monoxide Indicator* as shown in Fig. 11 has a double scale of which one gives full deflection for 100 ppm. It presents the same lack of zero setting provisions as the previously shown instrument, and in order to be able to obtain a zero at the testing location, an all-purpose cannister was attached to the device. With

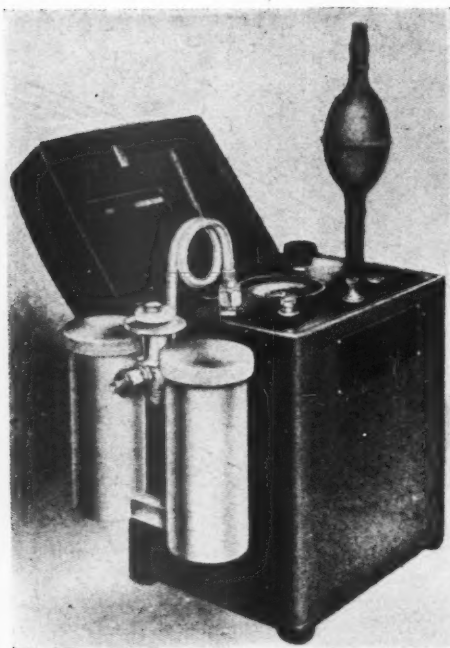


Fig. 13
M.S.A. Benzol Indicator

this attachment, we are now confident that we are able to determine carbon monoxide with an accuracy of plus or minus 5 ppm.

Fig. 12 shows an aspirating device which we constructed for use with the *Bureau of Standards Colorimetric CO Indicating Tubes* when a commercial type aspirator was not available for this purpose. It is easily constructed from a 50 cc syringe and a few pieces of wood. The correct rate of flow is obtained by selecting the proper size of needle and loading the plunger with shot through the hole drilled in the handle. Since the color indicating tube is sensitive to the rate of flow, this device has the advantage over the commercial type of having its rate of flow easily checked.³

Benzol Determination

THE M.S.A. Benzol Indicator is shown in Fig. 13 and is probably the most cussed and discussed instrument I know of. It too is an instrument where the weight is excessively high, the case being made of cast metal. The instrument, when delivered to

us, weighed about 19 pounds. The purge and test cylinders attached to the side contain chemicals for drying and for obtaining zero setting in the contaminated atmosphere. The chemical cartridges together weigh less than $\frac{1}{2}$ a pound. The holder for the chemicals weighs approximately $3\frac{1}{2}$ pounds.

In order to facilitate the use of this instrument, the vital parts were moved into a light wooden case, and the heavy cannister arrangement replaced by a lighter unit of homemade construction, thus cutting off eight pounds of the total weight of the instrument (Fig. 14).

At first, the procedure of the New York Division of Industrial Hygiene was adopted; namely, that of not using any drying cannister. By experiments in the laboratory with known concentrations of benzene in air, it was found that equal deflections of



Fig. 14
Light-weight assembly for Benzol Indicator

the needle were obtained whether the air passed through a drying agent or not. This left us without means for zero setting in the field, consequently the use of a cannister containing activated charcoal was provided.

In operation, the instrument was zeroed with the cannister connected, and after the zero had been obtained, air was drawn directly into the instrument. However, it was found that at times the charcoal either

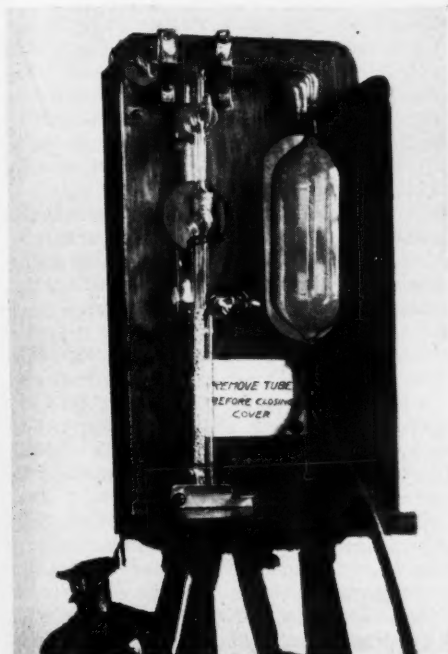


Fig. 15

Apparatus for U. S. Bureau of Mines Benzol Method

removed or added a certain amount of moisture to the gas mixture and it was necessary to determine and apply a correction.

Another modification that was undertaken with the instrument was to increase its sensitivity by completely short circuiting the resistance used for adjusting sensitivity. Thus, we were able to obtain full scale deflection for about 700 ppm, in terms of benzene, instead of the 1000 ppm it indicated when delivered.

We have, in the past, been using this instrument for combustible vapors other

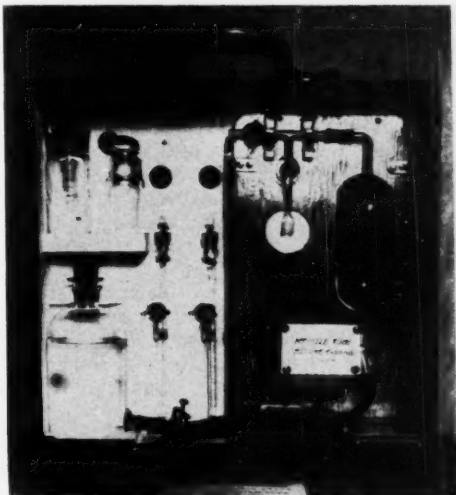


Fig. 16

Carrying case for U.S. Bureau of Mines Benzol Method

than benzene in the manner just mentioned with a fair degree of success. However, it cannot always be used for combustible vapors of all kinds. As a matter of fact, we have at times had the instrument running backwards, indicating less than zero. This is especially the case when butyl acetate vapors are predominant.

For this reason, we are now contemplating returning to the use of drying and absorption cannisters. However, we will plan to arrange these in a different manner than originally provided, enabling us to get an accurate zero at the point of testing.





DETECTION OF HYDROGEN SULPHIDE STANDARD STAINS PRODUCED ON LEAD ACETATE PAPER				
				
Number of Stains	Parts of H_2S per Million parts of Air			
2	33	55	80	133
4	17	26	38	67
6	11	17	26	42
10	7	10	15	25

Fig. 17

Standard stains on hydrogen sulfide test paper

Since the MAC value of benzene has been lowered to 50 ppm,* the benzol indicator is practically obsolete for this vapor and it has been necessary to return to the chemical determinations published by the Bureau of Mines.⁴ Fig. 15 shows a field instrument developed to utilize the type of nitration tubes specified by that method. The principal characteristic in the design is the provision for rapid exchange of prepared tubes by means of interchangeable glass joints.

Fig. 16 shows the front compartment of the carrying case with two spare tubes and containers for the necessary reagents. The rear compartment contains a supply of seven extra absorption tubes.

Colorimetric Filter Paper Tests

THE STANDARD stains appearing on lead acetate paper for determination of hydrogen sulfide as described by the Department of Scientific and Industrial Research, Great Britain, are shown in Fig. 17. Chemists usually frown upon the use of test papers, and the methods are usually described as qualitative or semi-quantitative. However, I believe that the Bureau of Standards has amply demonstrated in its development of the CO indicating tube that sensitive colorimetric stains may be made fully as accurate as other chemical methods, providing conditions under which the stains are obtained are controlled. One objection to using artificial standards such as this is that difficulties arise in matching the

stains. If a photometric device could be used to estimate the intensity and if reproducible stains could be obtained, we could have methods favorably comparable to other chemical methods employing colorimetry.

Fig. 18 shows the graphic design of a colorimeter constructed for measuring the intensity of filter paper stain.⁵ Essentially, it consists of a light source from which the light passes through a condensor lens in parallel beams, illuminating the surface of the paper, and reflects light down upon a photo cell. The light is controlled by the use of two polaroid screens, one of which is capable of being rotated. In practice, an unstained paper is placed upon the stage; the light is adjusted to cause maximum deflection on needle; the stain is then inserted, and the reflection read on the meter. If stains obtained from known concentrations are read, the corresponding percent reflection may be plotted on a semi-logarithmic chart. Another advantage is the fact that, in case the paper is unevenly stained due to poor distribution of the gas being tested, it is still possible to obtain a reading of the average intensity due to the integrating feature of the photo cell.

The instrument as constructed in our laboratory is shown in Fig. 19. It is mostly put together from scrap lumber using ordinary hand tools.

Fig. 20 shows the method by which stains are obtained in the field. Principally, it consists of a test paper holder connected to a reconverted tire pump. In order to obtain a steady rate of flow which is essential in test paper sampling, a weight is attached

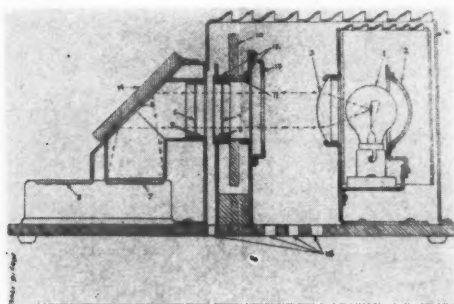


Fig. 18
Elevation of photometric device

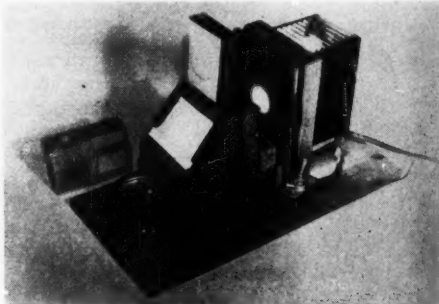


Fig. 19
Photometric device for measuring stain intensity

*Since this paper was delivered an MAC value for benzene of 35 ppm has been adopted by the American Conference of Governmental Industrial Hygienists.

to the handle, permitting the piston to move at a steady rate. A hypodermic needle is inserted in the inlet to serve as a constricting orifice. By proper selection of orifice and weight, the correct rate of flow is determined by experiment.

These are just a few samples of improvements, which the industrial hygienist has had to figure out in order to increase accuracy and efficiency in his sampling technic. Even the non-instrumental sampling technics are lacking in suitable devices for field sampling. For instance, none of the chemical supply houses lists an absorber, with the exception of the impinger, of a design suitable to be handled in the field. Nor can such a simple device as a test paper holder be found in their catalogs.

Conclusions

FROM THE foregoing, the impression may have been gathered that the state of instrumentation when it comes to field sampling is still more or less in the horse and buggy era. In my opinion, this is not very far wrong. The need for better indicating instruments is great and the lack of them is severely felt. Particularly is this true about organic vapors, the determination of which has always presented difficulties. With most of the MAC values at 200 ppm and below, the need for greater sensitivity is especially urgent.

Practically all of the present-day field instruments need to be redesigned to meet the requirements for sensitivity and re-engineered to eliminate excessive weights.

If my appraisal is correct, the ultimate question is: How can we, as a group, effect a better situation? Frankly, I do not exactly know how this could be done. I do not think the present suppliers of instruments are sufficiently interested to maintain the necessary development cost to produce the ideal field equipment.

Perhaps we should learn a lesson from some of the larger industries and develop our own designs and have them made according to our own specifications. If we pool our resources in ingenuity and work out designs that all of us agree meet our demands, no doubt manufacturers could be found to make them. Perhaps the Com-

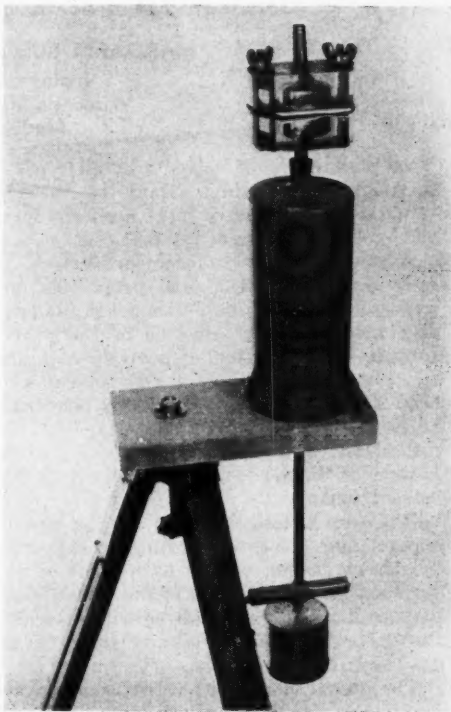


Fig. 20

Apparatus for sampling air through treated filter paper

mittee on Standardization of Field Instruments of the American Conference of Governmental Industrial Hygienists could be used as a clearing house to consolidate ideas and suggestions to be incorporated in approved designs, which later could be made commercially available through the efforts of the Committee.

References

1. SETTERLIND, A. N.: An Automatically Controlled Suction Device. Illinois Department of Public Health, Division of Industrial Hygiene. *What's New in Industrial Hygiene*, 4:3, 1948.
2. SETTERLIND, A. N.: Determination of Chlorinated Hydrocarbons. *Ibid.* 4:1, 1947.
3. SETTERLIND, A. N.: Aspirating Device for NBS CO Indicating Tubes. *Ind. Hyg. Newsletter*, 8:2, 1948.
4. SCHRECK, H. H., PEARCE, S. J., and YANT, W. P.: A Microcolorimetric Method for the Determination of Benzene. U. S. Bureau of Mines R.I. 3287, 1935.
5. SETTERLIND, A. N.: Photometric Device for Measuring the Intensity of Stains. *What's New in Industrial Hygiene*, 4:4, 1948.

Chlorinated Hydrocarbon-Hydrocarbon Solvent Mixtures

MARGARET SUSOR and WILLIAM L. LEA

Industrial Hygiene Unit
Wisconsin State Board of Health
Madison, Wisconsin

INDUSTRIAL use of solvents of all types is steadily increasing. Many of the solvents used in industry have been employed on a commercial scale for many years, and consequently their solvent properties, as well as their toxicological properties, are well recognized by the personnel in industry responsible for the selection of the proper solvent for a particular purpose and also for the safe handling of the solvent process. Safe handling is generally concerned with two properties of solvents: (1) the fire hazard, and (2) the toxicity, due to exposure of employees to the solvent or the solvent vapors.

The fire hazard involved in the use of a particular solvent is ordinarily evaluated by determination of the flash-point of the solvent. The flash-point is the lowest temperature, in degrees Fahrenheit, at which the solvent vapor will ignite under standardized test conditions.

The potential health hazard to employees due to inhalation of solvent vapors can only be evaluated by a careful study of the process under normal operating conditions including the determination of the peak, low and average concentration of the solvent vapors in the air at the breathing zone of the employees. Evaluation of the potential health hazard involved can then be made by comparing the atmospheric concentrations of solvent vapor or vapors, in case of a mixture, with accepted standards of maximum allowable concentrations in air for the solvents involved.

The data presented in this study deal with two component solvent mixtures. Both of the components, chlorinated hydrocarbons and petroleum hydrocarbons, are widely used as grease solvents. Aside from this common property, these two classes of solvents have other widely differing characteristics. Chlorinated hydrocarbons, such as carbon tetrachloride, trichlorethylene and perchlorethylene, have the desirable characteristic of either being non-inflammable or of burning with difficulty. These same

chlorinated solvents have the undesirable property of possessing a relatively high degree of toxicity. Petroleum hydrocarbons within the boiling range of 95° to 415°F possess opposite characteristics. The hydrocarbons in this range are of a relatively low order of toxicity but their use, especially the lower members, involves an appreciable fire hazard since their flash-points range from -41°F to 140°F.

This study of chlorinated hydrocarbon-petroleum hydrocarbon mixtures was made to determine what changes in characteristics are obtained in mixtures of these two types of solvents.

Procedure

THE SOLVENTS used in this study were standard commercial grades and were obtained either from industrial users or from solvent distributors. The commercial chlorinated solvents were fractionally distilled and the specific gravities of the distillates were determined by pycnometer in order to obtain materials in which the boiling point and specific gravity values agreed with accepted values. The commercial petroleum hydrocarbons were fractionally distilled to obtain solvents having the correct boiling ranges.

In determining flash-points of solvent mixtures, 100 ml. of each mixture were prepared volumetrically and 50 ml. used for the determination of the flash-point in a TAG closed cup tester.

The changes in solvent mixture composition occurring during evaporation were determined by starting with 50% by volume mixtures of hydrocarbon-chlorinated hydrocarbon. Of each solvent mixture, 100 ml. was placed in a 250 ml. fritted glass disk gas washing bottle and aerated at a rate of 1.0 liter of air per minute. The aeration was continued until 80% by volume of the mixture was evaporated.

The composition of the mixtures was determined at various stages during the evaporation by pycnometric determination of

the specific gravity. The temperature of the mixtures during evaporation varied from 20°C to 23°C.¹ This method of evaporation was checked against evaporation of some of the same solvent mixtures in open dishes using a large excess of air blowing over the surface and was found to give comparable results in regard to change in solvent composition upon evaporation.

Presentation and Discussion of Data

IN TABLE I are shown the flash-points (closed cup) for the various hydrocarbon-chlorinated hydrocarbon mixtures studied.

In Table I it is to be noted that mixtures of any of the three chlorinated hydrocarbons with either petroleum ether (flash-point -41°F) or textile spirits (flash-point -24°F) offer no advantage either from a health or a fire hazard standpoint. Both of these hydrocarbons are so flammable that very high concentrations of the chlorinated hydrocarbons are required to produce solvent mixtures of high flash-point.

In the case of V.M. & P. naphtha (flash-point 28°F), it is practical to produce mixtures of elevated flash-point only through the use of carbon tetrachloride. The data in Table I show that with trichlorethylene and perchlorethylene, it is necessary to have concentrations of 80% and 90% respectively of chlorinated hydrocarbon in mixtures with V.M. & P. naphtha in order to elevate the flash-point above 110°F.

With Sovasol, a commercial brand of a hydrocarbon solvent having a flash-point of 105°F, it is practical to produce high flash-point mixtures with all three chlorinated hydrocarbons. In Table I, it is shown that a solution of 10 percent carbon tetrachloride by volume in Sovasol elevates the flash-point above 185°F. Likewise, a solution of 25% trichlorethylene in Sovasol has a flash-point above 185°F. In order to produce a mixture having the same flash-point elevation using perchlorethylene, it is necessary to add to Sovasol at least 40% by volume of this chlorinated hydrocarbon.

The solvent, "140F," as the name indicates, is a hydrocarbon having a flash-point of 140°F or higher. The fire hazard associated with the use of a solvent having a flash-point above 140°F is not great; however, it is possible to further elevate the

flash-point by the addition of chlorinated hydrocarbons. The data in Table I show that the addition of 10% by volume of either carbon tetrachloride or trichlorethylene, or the addition of 20% of perchlorethylene to the hydrocarbon solvent, 140F, produces a solvent mixture which does not flash at 185°F.

The data in Table I show that the flash-point of a hydrocarbon solvent may be elevated by the addition of a chlorinated hydrocarbon. It is also evident that the flash-point of any mixture varies with the concentration of the chlorinated hydrocarbon. In using hydrocarbon-chlorinated hydrocarbon mixtures for the purpose of reducing fire hazard, this variation becomes of major importance. This point may be illustrated by assuming that a mixture composed of 50% V.M. & P. naphtha and 50% carbon tetrachloride having a flash-point of over 110°F is selected as a suitable solvent for a given operation. During the use of this solvent mixture, a portion or all of it may be evaporated and since carbon tetrachloride is more volatile than V.M. & P. naphtha, the solvent mixture becomes progressively richer in V.M. & P. naphtha as the evaporation proceeds. This enrichment of the remaining solvent mixture in respect to the naphtha component lowers the flash-point. In Table II it is shown that when 60% of the original 50-50 mixture has been evaporated, the composition of the solvent mixture remaining is 37% carbon tetrachloride and 63% V.M. & P. naphtha. Reference to Table I shows that the flash-point of a mixture of this composition is approaching a dangerously low value.

The data in Table II are based upon a study of mixtures having an initial total volume of 100 ml. and an initial concentration of 50%, by volume, of chlorinated hydrocarbon in petroleum hydrocarbon. The data show the changes in composition which occurred upon progressive evaporation. For the mixtures studied, it is possible through use of the data in Table I and Table II to evaluate the fire hazard involved not only with the original mixture but also with the solvent mixture remaining after partial evaporation.

In comparison with aliphatic petroleum hydrocarbons, the chlorinated hydrocarbons possess a relatively high degree of toxicity.

TABLE I
FLASH-POINTS OF HYDROCARBON-CHLORINATED HYDROCARBON MIXTURES

% Petroleum Ether	Flash Points of Mixtures in °F			% Textile Spirits	Flash Points of Mixtures in °F			% V. M. & P.	Flash Points of Mixtures in °F		
	Carbon Tetra-chloride	Trichlor-ethylene	Perchlor-ethylene		Carbon Tetra-chloride	Trichlor-ethylene	Perchlor-ethylene		Carbon Tetra-chloride	Trichlor-ethylene	Perchlor-ethylene
100	41	41	41	100	24	24	24	100	28	28	28
80	31	31	31	80	18	18	18	80	17	17	17
60	26	26	26	60	8	8	8	60	13	13	13
40	15	15	15	40	0	0	0	40	56	56	56
20	3	3	3	20	0	0	0	20	*	*	*
10	18	18	18	10	16	16	16	10	6	6	6
5	111	111	111	5	32	32	32	5	3	3	3
					20	20	20		29	29	29
					10	10	10		52	52	52
					50	50	50		50	50	50

% Sovasol No. 5	Flash Points of Mixtures in °F			% 140°F	Flash Points of Mixtures in °F			% 140°F	Flash Points of Mixtures in °F		
	Carbon Tetra-chloride	Trichlor-ethylene	Perchlor-ethylene		Carbon Tetra-chloride	Trichlor-ethylene	Perchlor-ethylene		Carbon Tetra-chloride	Trichlor-ethylene	Perchlor-ethylene
100	105	105	105	100	140	140	140	100	28	28	28
80	90	90	90	80	107	107	107	80	17	17	17
60	76	76	76	60	116	116	116	60	13	13	13
40	70	70	70	40	120	120	120	40	56	56	56
20	60	60	60	20	127	127	127	20	*	*	*
10	50	50	50	10	145	145	145	10	6	6	6
5	111	111	111	5	140	140	140	5	3	3	3

* No flash at 110°F
† No flash at 185°F

TABLE II
CHANGE IN SOLVENT MIXTURE COMPOSITION UPON EVAPORATION

% of Initial Vol. Evaporated	Petroleum Ether			Textile Spirits			V. M. & P. Naphtha			Sovasol No. 5		
	Carbon Tetra-chloride	Pet. Ether	%	Carbon Tetra-chloride	Textile Spirits	%	Carbon Tetra-chloride	V. M. & P.	%	Carbon Tetra-chloride	Sovasol No. 5	%
0	50	50	50	50	50	50	50	50	50	50	50	50
20	55	45	51.5	45	45	45	44	56	41	59	38.5	60.5
40	63	37	48	37	37	37	33	53	29	67	29	71
60	71	29	43	29	29	29	27	53	11	89	6	94
80	75	25	43	25	25	25	15	85				

% of Initial Vol. Evaporated	Petroleum Ether			Textile Spirits			V. M. & P. Naphtha			Sovasol No. 5		
	Carbon Tetra-chloride	Pet. Ether	%	Carbon Tetra-chloride	Textile Spirits	%	Carbon Tetra-chloride	V. M. & P.	%	Carbon Tetra-chloride	Sovasol No. 5	%
0	50	50	50	50	50	50	50	50	50	50	50	50
20	55	45	52.5	45	45	45	44	56	40	59.5	40	60
40	63	37	48	37	37	37	33	56	31	69	29	71
60	71	29	43	29	29	29	27	56	8	92	5	95
80	75	25	43	25	25	25	18	82				

% of Initial Vol. Evaporated	Petroleum Ether			Textile Spirits			V. M. & P. Naphtha			Sovasol No. 5		
	Carbon Tetra-chloride	Pet. Ether	%	Carbon Tetra-chloride	Textile Spirits	%	Carbon Tetra-chloride	V. M. & P.	%	Carbon Tetra-chloride	Sovasol No. 5	%
0	50	50	50	50	50	50	50	50	50	50	50	50
20	55	45	49.5	45	45	45	44	56	41.5	58.5	42	58
40	63	37	47	37	37	37	33	56	30	70	37	63
60	71	29	42.5	29	29	29	27	56.5	49.5	95	19	81
80	75	25	42.5	25	25	25	17	82				

The toxic effects associated with the use of solvents of this type are usually due to respiration of air containing excessive concentrations of solvent vapor. Where chlorinated hydrocarbons are employed as solvents, it is possible through the use of petroleum hydrocarbon-chlorinated hydrocarbon mixtures to decrease employee exposure to chlorinated hydrocarbons. There are, of course, many cases where a solvent mixture of this type cannot be employed due to other considerations such as temperature, solvent power, drying rate. However, in many cases, especially room temperature processes, a solvent mixture of aliphatic petroleum hydrocarbons with chlorinated hydrocarbons may be successfully employed in the place of a chlorinated hydrocarbon solvent.

In Table III are data from a study of evaporation of 50-50 percent by volume mixtures of chlorinated hydrocarbons with various commercial grades of petroleum hydrocarbons.

The data in Table III were obtained by evaporating at room temperature (20°-23°C), with excess air, one-fourth of the 100 ml. starting volume of the mixtures. The composition of mixtures of this type changes progressively during evaporation and the data presented apply only to the evaporation of the first 25% by volume of the solvent mixtures studied.

Assume, as an example, that carbon tetrachloride is being used in a process to clean an article and that the solvent is brushed on and the solvent treated article is then removed from the breathing zone of the employee and dried under controlled ventilation. In this case, the employee is exposed to carbon tetrachloride vapors resulting from evaporation of the solvent during the brushing application and transfer of the cleaned article. The concentration of carbon tetrachloride at the breathing zone of the employee can be substantially reduced if a solvent mixture composed of 50-50% by volume of carbon tetrachloride and V. M. & P. naphtha is used in place of carbon tetrachloride. The data in Table III show the evaporation rate of this mixture to be only 61% that of carbon tetrachloride and the vapor resulting from evaporation of the solvent mixture to be 25% petroleum hydrocarbon. Obviously then, through the use of this solvent mixture, the concentration of carbon tetrachloride vapor in air is reduced to $.61 \times .75 = 46\%$ of the concentration resulting from the use of carbon tetrachloride alone. From Table III, the concentration of chlorinated hydrocarbon vapor from the evaporation of any of the various hydrocarbon-chlorinated hydrocarbon mixtures under consideration can be determined.

TABLE III
EVAPORATION RATES AND VAPOR COMPOSITION OF
HYDROCARBON-CHLORINATED HYDROCARBON SOLVENT MIXTURES

Starting Mixture % by Volume		Relative Evaporation Rate of Mixture	Vapor Phase Composition	
Chlorinated Hydrocarbon	Petroleum Hydrocarbon		% Chlorinated Hydrocarbon	% Petroleum Hydrocarbon
100% Carbon Tetrachloride	0	1.00	100	0
	Petroleum Ether	1.90	30	70
	Textile Spirits	1.36	42	58
	V. M. & P. Naphtha	.61	75	25
	Sovasol No. 5	.42	89	11
50% Carbon Tetrachloride	140°F	.41	90	10
100% Tri- chloroethylene	0	.67	100	0
	Petroleum Ether	.94	30	70
	Textile Spirits	.86	40	60
	V. M. & P. Naphtha	.36	71	29
	Sovasol No. 5	.32	87	13
50% Tri- chloroethylene	140°F	.26	85	15
100% Per- chloroethylene	0	.17	100	0
	Petroleum Ether	.91	10	90
	Textile Spirits	.62	29	71
	V. M. & P. Naphtha	.24	42	58
	Sovasol No. 5	.11	85	15
50% Per- chloroethylene	140°F	.08	80	20

Summary

DATA HAVE been presented which make possible the selection of hydrocarbon-chlorinated hydrocarbon mixtures having flash-points sufficiently high to reduce the fire hazard usually associated with the use of petroleum hydrocarbons. Mixtures involving the more volatile hydrocarbons such as petroleum ether, textile spirits, and in some cases, V.M.&P. naphtha appear to be impractical as a very high concentration of chlorinated hydrocarbon is required to elevate the flash-point above 110°F.

Most mixtures of this type undergo change in composition upon progressive

evaporation and become richer in the less volatile component.

A comparison was made of the evaporation rates of 50% by volume mixtures in relation to the evaporation rates of the chlorinated hydrocarbons.

From the evaporation rate and also the data presented on vapor phase composition, the reduction in atmospheric concentration of chlorinated hydrocarbon resulting from the use of 50-50 mixtures may be computed.

Reference

1. GLASSTONE, S.: Text Book of Physical Chemistry. D. Van Nostrand, pp. 693, 703-704, 1946.

Health Control in Industrial Lead Workers

THE LEAD Industries Association, New York City, has published a booklet combining reprints of three papers on important aspects of health control in industrial lead workers delivered at a recent meeting of the association.

WILLIAM C. WILENTZ, M.D., Medical Director of the Perth Amboy Plant of the National Lead Company, in "A Medical View of the Lead Problem," discusses in turn the employer, employee and community factors of the problem and presents a series of ten conclusions looking toward their control.

LLOYD E. HAMLIN, M.D., Medical Director, and HERBERT J. WEBER, Industrial Hygienist of the American Brake Shoe Company, set forth their views on the medical and engineering aspects of prevention of lead intoxication among brass foundry workers in two concise and well-illustrated articles.

While the limited edition lasts, members of the AIHA may secure single copies of this triple reprint without charge from the Lead Industries Association, 420 Lexington Avenue, New York 17, N. Y. To non-members the reprints are 50c each.

Is It Necessary to Ventilate All Degreasing Installations?

B. F. POSTMAN
Industrial Hygiene Engineer

"IS IT NECESSARY to ventilate my degreasing units?"

How often the industrial hygiene engineer is confronted with this question which has really become a serious problem inasmuch as it is directly concerned with the health of many industrial workers.

Much has been written relative to the desirability of or the necessity for ventilating degreasing units. Some state regulations require ventilation. It seems that the first reaction is to "ventilate," without actually making an unbiased survey of each installation to determine if ventilation is necessary.

How many industrial hygiene chemists or industrial hygiene engineers actually study an individual degreasing installation before, during, or after vapor determinations have been made to ascertain just what conditions may be responsible for the dispersed solvent vapors? How many reports of vapor studies at degreasing installations mention the causative factors which may be responsible for the toxic vapor dispersion? Yet, report after report, as well as published studies in our technical literature, as a rule, fail to mention this most important question: "Granted that vapor concentrations at a given installation are high, what are the reasons for these concentrations?" Almost always, the answer, as indicated in the report, will still call for ventilation of the unit.

It should not be inferred from the above statements that properly applied, adequate ventilation may not be necessary for some degreasing installations. However, before ventilation is recommended, an evaluation should be made to determine whether this is the correct answer to the problem.

Surely if a person is ill, his physician does not immediately hospitalize him and operate. A complete physical examination is usually in order. An analysis is then made of this examination, possible causative factors are isolated and then a course of treatment or operation is decided upon. Why isn't this a logical procedure as far as degreasing units are concerned? If we

assume that excess vapor dispersion from a degreasing installation is evident—if this assumption is then corroborated by actual field tests—why should the usual final answer be "Ventilate?"

Some Responsible Factors:

THERE ARE many causative factors which may be responsible, individually or in combination, for high toxic vapor dispersion from some degreasing installations. These are listed as follows:

1. Open windows adjacent to unit.
2. Openings, adjacent to unit, between plant operating areas.
3. Man cooler fans or unit heaters which tend to drive vapors out of open degreasing tanks to the breathing zone of the operator and to the general work area.
4. Excessive and uncontrolled steam pressure at heating coils.
5. Uncovered steam line feeding heating coils. The aspirating effect of the thermal air currents at the sides or rear of the unit act as ejectors to the air in the vicinity of the unit. Once air movement starts, a condition of unstable equilibrium exists with resulting vapor movement from within the tank.
6. Insufficient water feeding cooling coils or cooling jackets. This is usually an important, though rarely checked factor which may cause excessive vapor dispersion from the tank.
7. Cooling water to the unit may be too warm. In some localities this is a problem, particularly during the summer months. Increased water quantity may be the only economic answer to this problem.
8. Uncovered stack, leading to outdoors, conveying products of combustion from gas-fired units. The action in the vicinity of the tank is similar to that described under item 5.
9. Use of trichlorethylene solvent in units designed for perchlorethylene solvent without any change being made in thermostat setting. *Fundamentally, only the solvent recommended by the manufacturer of the unit should be used in the unit.*

10. Excessive rate of downward or upward movement of work into or out of unit. This is probably the most important item causing excess toxic vapor dispersion to the breathing zone of the operator and is one which is most difficult to control.

11. Excessive drag-out of solvent due to faulty racking of material or due to recesses in materials being processed.

12. Unnecessary hand shaking of basket of degreased parts to remove excess solvent. This is usually done while the basket is either being withdrawn from the tank or is directly in the breathing zone of the operator. With round baskets, some operators roll the basket along the inner forward edge of the tank. This usually causes excessive vapor concentrations in the breathing zone, with loss of valuable solvent not only to the clothes of the operator but also to the floor area in front of the tank.

13. Location of unit adjacent to exhaust systems such as buffing and polishing, plating or metal cleaning tanks, spray booths or wall propeller fans.

14. Location of unit near stair or elevator wells.

15. Location of unit close to machinery operated by belts from line shafts or jack shafts.

16. Too many operators. not properly instructed, using unit.

17. Covers on units not used when unit is not operating continuously.

18. Sluggish action of thermostatic controls.

19. Excessive metal load in unit far beyond the original design requirements.

20. Excessive operator activity or speed about or in front of unit, which with item No. 10 may be responsible for much of the exposure at degreasing units.

21. Poor operator technique with emphasis of items No. 10-11-12-16-17-19-20.

Previous to World War II, some manufacturers of degreasing equipment provided monthly engineering inspection of their installations. This constructive sales weapon may be considered as the most important control item as far as the industrial hygiene engineer is concerned. It was during these visits that operating mal-practices were discovered and corrected.

However, with the advent of the war, conditions changed rapidly. Field service

engineers of the degreasing equipment manufacturers were called to the Service. War production demands resulted in the sale and installation of an unprecedented increase of degreasing equipment all over the country. Inexperienced war workers, fluctuating personnel, pressure of production demands and the absence of almost all supervision in many instances, resulted in exposure to high concentrations of toxic solvent vapor from degreasing units. It is hoped that these conditions have not only subsided but have been eliminated so that normal industrial operations may be the rule instead of the exception.

Moot Question

THE PROBLEM of specific ventilation requirements for open degreasing tanks is still a moot question. The low air quantities recommended by the manufacturers of the equipment range from approximately 40-60 cfm per square foot of tank surface. These air quantities are much less than the requirements based on cfm per foot of tank perimeter. Low air quantities result in less solvent loss, which at approximately \$1.10 per gallon means an economical installation. Due to the variable locations and operating conditions, how can a specific attitude be assumed relative to ventilation requirements until each installation is analyzed?

It does not seem possible that adequate engineering consultation is being utilized by purchasers of degreasing equipment to prevent the installation of units in plant locations which have low ceilings, is small isolated areas, or adjacent to sources of potential vapor dispersion as outlined in the above listing of "causative factors." If such service is available, the results have not been satisfactory. Since the solvents used in degreasing operations are toxic and potentially dangerous to the health of operators and adjacent workers, would it be out of order to have field service engineers of the manufacturers of degreasing equipment consult with state Bureaus of Industrial Hygiene prior to the installation of such equipment? Consultation previous to and inspection after each installation with possible atmospheric determinations would tend to elevate the position which degreasing equipment should maintain in the metal processing plants of this country.

